AD 607461

an index of electronic equipment operability

DATA STORE

Best Available Copy

DDC
OCT 21 1964
AMERICAN INSTITUTES FOR RESEARCH
DDC-IRA C

AIR-C43-1/62-RP(1)

An Index of Electronic Equipment Operability

DATA STORE

Sara J. Munger
Robert W. Smith
Dan Peyne

American Institute for Research
Pittsburgh, Pennsylvania

31 January 1962

Contract No. DA-36-039-SC-80555
Signal Corps Technical Requirements EWD

Copyright © 1962

by the American Institute for Research

The United States Government and its officers, agents, and employees, acting within the scope of their duties, may reproduce, publish, and use this material in whole or in part for governmental purposes without payment of royalties thereon or therefor.

The publication or republication by the Government either separately or in public document, of any material in which copyright is subsisting shall not be taken to cause any abridgment or annulment of the copyright or to authorize any use of appropriation of such copyright material without the consent of the copyright proprietor.

The Data Store contains the time and operator reliability data to be used with the Index of Electronic Equipment Operability. The Data Store is one of five related documents. In addition to the data, the Instruction Manual and Evaluation Booklet are required for conducting an evaluation. The Sample Equipment Evaluations report contains detailed reports of the evaluation of four equipments, including recommendations. The Report of Development constitutes the final technical report, and describes the development of the Index.

[redacted]

CIRCULAR SCALES

BASE TIME = .50

Time added	Reliability
1.03	.9996
0	.9997
.03	.9993
1.50	.9966
1.50	.9967
.25	.9965
.25	.9975
0	.9999
0	.9990
1.40	.9987
3.50	.9900

1. Scale diameter
   a. 1"
   b. 1.6-1.75"
   c. 2.75"
2. Scale style
   a. Quantitative reading (Determine a specific value.)
      (1) Moving pointer
      (2) Moving scale
   b. Qualitative reading and checking (Determine whether indication is within a certain range.)
      (1) Moving scale
      (2) Moving pointer
      (3) Either moving pointer or moving scale, if color coded.
3. Pointer style
   a. Conventional, horizontal bar, 0 at base
   b. Triangle or vertical bar at base (Pointer base = short end of pointer.)
4. Parallax (Distance the pointer is from the scale face, resulting in misreading when viewed from an angle.) If parallax is sufficient to result in an error of one graduation mark (for quantitative read), these data apply.

CIRCULAR SCALES

Time added	Reliability
2.70	.9975
1.10	.9986
0	.9996
0	.9996

CIRCULAR SCALES (cont.)

5. Interval spacing (Physical distance between marks)
   a. Less than 1/20 inch
   b. More than 1/20-1/4 inch
   c. More than 1/4-2 inch
6. Number of graduation marks per unit of required resolution. (The assessment of this parameter involves two simple steps:
   1. Define required resolution, e.g., must read to 5^{o}.
   2. Determine number of graduation marks used for each five degrees represented on the scale.

   A graduation mark for each degree (5:1) would be inappropriate, since the unit of required resolution is five degrees. On the other hand, the presence of one graduation mark for every 20^{o} (1:4) also would be inappropriate, since a high degree of interpolation would be necessary in order to read to the required resolution.

   It should be noted that the determination of the units of required reading resolution, while absolutely necessary for assessment of the parameter discussed here, is not, in itself, a parameter requiring evaluation.)

CIRCULAR SCALES (cont.)

Time added	Reliability
0	.9999
.50	.9991
2.00	.9980
0	.9996
.50	.9984
1.50	.9962
2.50	.9952
2.50	.9965
1.75	.9955
0	.9995
.75	.9985
.35	.9992
0	.9994
.43	.9990
.35	.9985

7. Proportion of graduation marks numbered
   a. 1:1
   b. 1:5
   c. 1:10
8. Number of units represented
   a. 50-100
   b. 200
   c. 400
   d. 600
9. Scale brightness
   a. Imperceptible from normal position, must move closer.
   b. Minimally perceptible from normal position.
   c. Easily perceptible from normal position.
10. Alignment position of pointer (Position assumed by pointer when condition is neutral or normal.)
    a. All dials uniform (identical markings)
       (1) 3 o'clock
       (2) 6 or 12 o'clock
       (3) 9 o'clock
    b. Mixed dials (dissimilar markings)
       (1) 3 o'clock
       (2) 9 or 12 o'clock

Time added	Reliability
0	.9999
1.10	.9997
3.85	.9990
5.10	.9975
.55	.9996
0	.9999
0	.9997
.20	.9996
.06	.9966
.04	.9977

CIRCULAR SCALES (cont.)

11. Numbe.' of scales and arrangement
    a. 1 or 2 x 1
    b. 2 x 2, 2 x 4, 4 x 4
    c. 4 x 10, 6 x 4
    d. 8 x 4, 9 x 5
12. Scale increase
    a. Right to left
    b. Left to right
13. Exposure (viewing) time
    a. Indefinite
    b. .08-.15 sec.
    c. .30-.70 sec.
    d. 1.0-1.40 sec.

BASE TIME = .50

Time added	Reliability	
		1. Size (length)
.75	.9990	a. 1"
0	.9998	b. 1-2"
.10	.9995	c. 3" and up
		2. Number of drums (or digits)
0	.9997	a. 1-3
.25	.9993	b. 4-5
.75	.9985	c. 7 and up
		3. Style
.10	.9995	a. Continuously rotating
0	.9997	b. Unit jumps
		4. Use
0	.9999	a. Quantitative read
1.75	.9990	b. Qualitative read
		5. Numeral legibility
0	.9999	a. Clear and concise
.20	.9994	b. Potentially ambiguous

COUNTERS (cont.)

Time added	Reliability	
		6. Exposure (viewing) time
0	.3999	a. Indefinite
.20	.9996	b. .08-.15 sec.
.06	.9996	c. .30-.75
.04	.9999	d. 1.0 and up
		7. Recession (Extent to which counter numerals are set back in panel)
0	.9999	a. Numerals can readily be read from normal operating position.
.25	.9996	b. Requires movement of operator's head to read numerals.
1.00	.9993	c. Operator must shift entire body to read numerals.

[redacted]

LABELING

(Includes any labeling serving as the step input.)

BASE TIME = .20

Time added	Reliability	
		1. Span
		a. Digits
0	.9998	(1) 2
.11	.9994	(2) 3
.29	.9992	(3) 4-5
.71	.9991	(4) 6-7
		b. Words
0	.9999	(1) 1 or 2
.20	.9995	(2) 3-5
1.65	.9985	(3) 6-11
		2. Legibility
0	.9999	a. Clear and concise
.25	.9997	b. Potentially ambiguous
		3. Size of printing (height)
0	.9997	a. 1/5" or more
.20	.9994	b. 1/8"

LIGHTS

BASE TIME = .25

Time added	Reliability	
		1. Size (diameter)
.30	.9995	a. Less than 1/4"
.20	.9997	b. 1/4-1/2"
0	.9999	c. 1/2-1"
		2. Brightness
		a. Indicator
0	.9999	(1) 10 x background
0	.9997	(2) 2 x background
.20	.9995	(3) Less than 2 x background
		b. Caution and warning
0	.9999	(1) 10 x indicator lights
.20	.9998	(2) 2 x indicator lights
1.20	.9985	(3) Less than 2 x indicator lights
1.50	.9915	3. Caution lights should be red or amber, warning lights should be red. If not, these scores should be applied.
		4. Number of lights in visual field (lights ON)
0	.9998	a. 1-2
1.20	.9975	b. 3-4
2.40	.9952	c. 5-7
3.50	.9946	d. 8-10

LIGHTS (cont.)

Time added	Reliability
0	.9998
.20	.9996

5. Presentation
   a. Intermittent (blinking)
   b. Continuous illumination

LINEAR SCALES

BASE TIME = 1.00

Time added	Reliability	
		1. Size (length)
1.05	.9997	a. 3"
0	.9998	b. 6"
.15	.9996	c. 9"
		2. Scale style
		a. Quantitative reading (Determine a specific value.)
.90	.9979	(1) Moving pointer
.90	.9970	(2) Moving scale
		b. Qualitative reading or checking (Determine whether indication is within a certain range.)
.30	.9969	(1) Moving scale
.15	.9976	(2) Moving pointer
0	.9999	(3) Either moving pointer or moving scale, if color coded

Time added	Reliability
0	.9998
.40	.9995
1.50	.9975
.75	.9992
0	.9982

LINEAR SCALES (cont.)

3. Scale layout (Direction scale runs through its length)
   a. Horizontal
   b. Vertical
4. Interval spacing (Distance between graduation marks)
   a. 1/10" or less
   b. 1/10-1/4"
   c. 1/4" or more
5. Parallax (Distance the pointer is from the scale face, resulting in misreading when viewed from an angle. If parallax is enough to enable an error of one graduation mark, these data apply. Not relevant to qualitative read.

LINEAR SCALES (cont.)

Time added	Reliability	
		6. Number of graduation marks per unit of required resolution. (The assessment of this parameter involves two simple steps: 1. Define required resolution, e.g., must read to 5^{o}. 2. Determine number of graduation marks used for each five degrees represented on the scale. A graduation mark for each degree (5:1) would be inappropriate, since the unit of required resolution is five degrees. On the other hand, the presence of one graduation mark for every 20^{o} (1:4) also would be inappropriate, since a high degree of interpolation would be necessary in order to read to the required resolution. It should be noted that the determination of the units of required reading resolution, while absolutely necessary for assessment of the parameter discussed here, is not, in itself, a parameter requiring evaluation.)
0	.9998	a. Every 1 or 2
1.13	.9990	b. Every 5
1.88	.9985	c. Every 10

LINEAR SCALES (cont.)

Time added	Reliability	
		7. Number of units represented (Number of units of required resolution represented on the scale.)
0	.9998	a. 50-100
.55	.9988	b. 200
1.45	.9968	c. 400
		8. Scale increase
0	.9998	a. Left to right (or bottom to top)
.55	.9992	b. Right to left (top to bottom)
		9. Proportion of graduation marks numbered
0	.9999	a. 1:1 or 1:2
.45	.9995	b. 1:5
1.60	.9985	c. 1:10
		10. Exposure (viewing) time
.24	.9952	a. .12 sec.
.03	.9983	b. .30-.36 sec.
.02	.9996	c. 1.00 sec.
0	.9999	d. Indefinite
		11. Scale illumination
2.45	.9975	a. Imperceptible from normal position, must move closer
1.20	.9962	b. Minimally perceptible from normal position
0	.9999	c. Easily perceptible from normal position

NON-SPEECH

BASE TIME = .23

Time added	Reliability	
		1. Intensity and tone
.77	.9950	a. Would not penetrate ambient noise level
.47	.9985	b. Would probably penetrate ambient noise level
0	.9999	c. Would obviously penetrate ambient noise level
		2. Duration
.15	.9965	a. .5 sec. or less
.08	.9968	b. 1.0 sec.
0	.9997	c. Intermittent
.05	.9995	d. Continuous
		3. Interval between signals (in seconds)
0	.9984	a. .04
.28	.9996	b. .08
.32	.9999	c. 1.2 and up

BASE TIME = 3.80

Time added	Reliability	
		1. Number of range marks
.50	.9980	a. 1 or 2
0	.9997	b. 3-5
0	.9999	c. 6-10
.30	.9990	d. 10-20
.80	.9983	e. 20 and up
		(If every 5th mark is not heavier, add .3 to time and subtract .0005 from reliability.)
		2. Bearing indication method
2.00	.9975	a. Estimate (no aid)
1.00	.9990	b. Use overlay
.50	.9995	c. Use cursor ("Track" target with cursor controlled by knob. At "lock on", read bearing from dial or counter.)
0	.9999	d. Use pantograph (Manually place crosshairs of pantograph over target and read bearing from a counter.)
		3. Third coordinate coding method
0	.9997	a. Color, numerals, and letters; geometric figures, stereo depth
.75	.9985	b. Area, visual number, length, angular orientation
1.50	.9965	c. Brightness, flash rate

SCOPES (cont.)

Time added	Reliability	
		4. Rate of target presentation
3.50	.9956	a. 10 per hour
3.00	.9971	b. 20 per hour
2.00	.9986	c. 30 per hour
1.00	.9990	d. 40 per hour
0	.9970	e. 1500 per hour
		5. Scope size (diameter)
2.00	.9990	a. 3"
.75	.9999	b. 4"
0	.9999	c. 5-7" and up
		6. Visual angle (from operator to scope face)
0	.9999	a. 0-45°
.70	.9995	b. 45-80°
		7. Target exposure time
.75	.9990	a. 3 sec.
.30	.9995	b. 5 sec.
0	.9999	c. Over 5 sec.
		8. Target velocity (inches per second)
0	.9999	a. .75
2.00	.9992	b. 1.75
3.00	.9985	c. 3.25

SEMI-CIRCULAR SCALE
(Includes open-window scales)

BASE TIME = .50

Time added	Reliability
1.15	.9996
.05	.9997
0	.9993
1.10	.9980
1.10	.9981
.10	.9982
.10	.9975
0	.9999
3.50	.9900

1. Size (radius)
   a. 1/2-3/4"
   b. 3/4-1"
   c. 1-2"
2. Scale style
   a. Quantitative information (Determine a specific value)
      (1) Moving pointer
      (2) Moving scale
   b. Qualitative information and checking (Determine whether indication is within a certain range.)
      (1) Moving pointer
      (2) Moving scale
      (3) With color or zone code
3. Parallax (Distance the pointer is from the scale face, resulting in untrue reading when viewed from an angle.) If parallax is sufficient to result in error of one graduation mark, these data apply. Not relevant to qualitative read.

Time added	Reliability
.13	.9937
0	.9950
.01	.9964
1.00	.9965
.10	.9933
0	.9955
0	.9969
.16	.9962
2.49	.9971
.35	.9960
0	.9998

SEMI-CIRCULAR SCALE (cont.)

4. Scale arc length (number of degrees included by scope face.)
   a. 25°
   b. 50-100°
   c. 200°
5. Scale interval spacing (Distance between graduation marks.)
   a. Less than 1/20"
   b. 1/20-less than 1/10"
   c. 1/10-less than 1/2"
   d. 1/2-less than 1"
   e. 1-less than 2"
6. Scale brightness
   a. Imperceptible from normal position, must move closer.
   b. Minimally perceptible from normal position.
   c. Easily perceptible from normal position.
7. Number of graduation marks per unit of required resolution (The assessment of this parameter involves two simple steps:
   1. Define required resolution, e.g., must read to 5°.
   2. Determine number of graduation marks used for each five degrees represented on the scale.

   A graduation mark for each degree (5:1) would be inappropriate, since the unit of required resolution is five degrees. On the other hand, the presence of one graduation

Time added	Reliability	
		mark for every 20° (1:4) also would be inappropriate, since a high degree of interpolation would be necessary in order to read to the required resolution.
		It should be noted that the determination of the units of required reading resolution, while absolutely necessary for assessment of the parameter discussed here, is not, in itself, a parameter requiring evaluation.)
0	.9996	a. Every 1 or 2 units
1.45	.9992	b. Every 5th unit
1.75	.9985	c. Every 10th unit
		8. Proportion of graduation marks numbered
0	.9999	a. 1:1 or 1:2
.80	.9995	b. 1:5
1.50	.9985	c. 1:10
		9. Scale increase
0	.9999	a. Left to right
.55	.9996	b. Right to left
		10. Exposure (viewing) time
.20	.9956	a. .075-.15 sec.
.06	.9966	b. .30-.70 sec.
.04	.9977	c. 1.0-1.4 sec.
0	.9997	d. Indefinite

SPEECH

BASE TIME = 2.02

Time added	Reliability	
		1. Intensity and tone
0	.9995	a. Would obviously penetrate ambient noise level
.75	.9990	b. Would probably penetrate ambient noise level
1.50	.9950	c. Would not penetrate ambient noise level
		2. Ambiguity (Reflects the way in which a statement is phrased: the meaning should be clear to be unambiguous.)
1.45	.9950	a. Potentially ambiguous
0	.9997	b. Obviously unambiguous
		3. Repetition (Refers to repetition of the entire speech input.)
0	.9991	a. None
.75	.9997	b. One

IDENTIFICATION/RECOGNITION

BASE TIME = .25

Time added	Reliability	
		1. Discrimination (Refers, in general, to the separation of one thing (stimulus event) from others.)
0	.9998	a. Heterogeneous (Refers to discriminations made among relatively unique or unlike events.)
3.42	.9987	b. Homogeneous (Refers to discriminations made among relatively similar events.)
		2. Recall (Refers to the retrieval of information from memory. The level of recall, as viewed here, is assumed to be primarily dependent upon the opportunity for learning the material in memory.)
0	.9997	a. Formal (Refers to recall of information for which there has been an opportunity to learn and practice sufficient to attain a high degree of proficiency. This assumes that contingent operations are either unlikely or well learned.)
2.57	.9992	b. Informal (Refers to recall of information for which there has been inadequate opportunity to learn or practice. The major assumption here is concerned with operating contingencies. That is, when operations depend upon uncontrollable external events (enemy action), the opportunity for learning is restricted.)

IDENTIFICATION/RECOGNITION (cont.)

Time added	Reliability	
		3. Compare (Refers, in general, to the process of examining for the purpose of discerning likenesses or differences. The concern here is with the process, and not that which is compared.)
0	.9996	a. Discrete (Refers to the process of comparing specific attributes or dimensions of information at a given moment in time.)
3.55	.9989	b. Continuous (Refers to the process of successive comparisons of attributes or dimensions of information through time.)

MANIPULATION

BASE TIME = .75

Time added	Reliability	
		1. Numerical
0	.9997	a. Simple (Refers to numerical operations that are virtually automatic.)
5.00	.9991	b. Compound (Refers to numerical operations that are either multiples of the above, or that require some modification of known operations.)
10.??	.9972	c. Complex (Refers to the development of new associations or relationships to fit novel situations.)
		2. Non-numerical
0	.9998	a. Simple (Refers to the manipulation of information in a manner virtually automatic.)
15.00	.9987	b. Compound (Refers to manipulations involving some modification of either the information or alternatives. This would include multiples of simple manipulations.)
35.00	.9968	c. Complex (Refers to manipulations where the end result is known, but its achievement is left to the ingenuity and expertise of the operator.)

CABLE CONNECTIONS

BASE TIME = .80

Time added	Reliability	
		1. Required force
0	.9997	a. Light (5 lbs. or less)
.75	.9992	b. Heavy (over 5 lbs.)
		2. Locking method
0	.9987	a. None
0	.9990	b. Automatic
.20	.9992	c. Less than 1/4 turn
.40	.9995	d. More than 1/4 to less than 1 turn
3.20	.9997	e. Clamp
2.75	.9999	f. Pin
6.50	.9999	g. Threaded
		3. Number of probes within the connection
0	.9998	a. None, one or two, or keyed
		b. Three or four
.40	.9992	(1) No particular placement required
.85	.9988	(2) Specific placement of probes required
		c. Five or more
.65	.9990	(1) No particular placement required
1.40	.9982	(2) Specific placement of probes required

CABLE CONNECTIONS (cont.)

Time added	Reliability	
		4. Use of tool(s) (Time and error to be considered for each tool used; above scores assume no tools.)
.85	.9990	a. Standard tool (wrench, screwdriver, etc.)
0	.9993	b. Special tool

CRANKS

The following parameters and data apply for single control operation. Many target acquisition (or tracking) applications require the simultaneous use of two controls. In these cases, the total time will be less than twice the sum of the individual times, but less than the time required for operation of a single control. The estimate for combined reliability should be even less than the product of the two individual reliabilities, but, of course, more than the independent.

Consideration of the factors listed below and the nature of the task as a whole, should suggest the magnitude of the time and reliability.

BASE TIME = 4.31

Time added	Reliability	
		1. Diameter
.73	.9970	a. 3"
.20	.9990	b. 4"
0	.9975	c. 8"
.28	.9985	d. 12"
		2. Control force
0	.9985	a. Less than 5 lbs.
1.00	.9972	b. 5-10 lbs.
		3. Control/display movement relationship (direction of movement)
0	.9992	a. Direct
2.30	.9975	b. Reverse

CRANKS (cont.)

Time added	Reliability	
		4. Time delay (Time lag between turn of control and movement of display.)
0	.9980	a. Less than 1.5 sec.
1.50	.9965	b. More than 2.0 sec.
		5. Control/display movement ratio (Number of complete revolutions per inch of cursor movement.)
0	.9975	a. 1:1
.35	.9990	b. 2:1
.50	.9992	c. 3:1
		6. Use of lock mechanism on control
1.00	.9999	a. Present
0	.9989	b. Absent
		7. Clarity of control indications (Labelling, meter scales, indicator lights, etc.)
.10	.9999	a. At least two indications of control positioning
0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

DISCONNECTING CABLES

BASE TIME = .50

Time added	Reliability	
		1. Force
0	.9999	a. Light (5 lbs. or less)
.50	.9997	b. Heavy (over 5 lbs.)
		2. Locking method
0	.9999	a. None
.20	.9999	b. Automatic
.30	.9998	c. Less than 1/4 turn
.50	.9999	d. More than 1/4 turn
4.20	.9995	e. Clamp
2.75	.9997	f Pin
6.15	.9999	g. Threaded
		3. Use of tool(s) (Time and error to be considered for each tool used; above scores assume no tools.)
3.20	.9996	a. Standard tool (wrench, screwdriver, etc.)
2.35	.9998	b. Special tool

JOYSTICK
(May move in many planes.)

BASE TIME = 1.93

Time added	Reliability	
		1. Stick length
1.50	.9963	a. 6-9"
0	.9967	b. 12-18"
1.50	.9963	c. 21-27"
		2. Extent of stick movement (Extent of movement from one extreme to the other in a single plane.)
0	.9981	a. 5-20°
.20	.9975	b. 30-40°
.50	.9960	c. 40-60°
		3. Control resistance
0	.9999	a. 5-10 lbs.
.50	.9992	b. 10-30 lbs.
		4. Support of operating member
0	.9990	a. Present
1.00	.9950	b. Absent
		5. Time delay (Time lag between movement of control and movement of display.)
0	.9967	a. .3 sec.
.50	.9963	b. .6-1.5 sec.
3.00	.9957	c. 3.0 sec.

JOYSTICK (cont.)

Time added	Reliability	
		6. Control/display movement ratio (Usually defined in terms of distance.)
3.00	.9936	a. 1:1 or 1:3
2.00	.9967	b. 1:4 or 1:6
1.00	.9950	c. 1:15
0	.9967	d. 1:30
		7. Control/display movement relationship (direction of movement)
0	.9998	a. Direct
2.00	.9970	b. Reversed
		8. Clarity of control indications (Labeling, meter scale. indicator lights, etc.)
.10	.9999	a. At least two indications of control positioning
0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

(No positions marked; usually used in conjunction with separate display; includes use of screwdriver to make adjustments.)

BASE TIME = 1.49

Time added	Reliability	
		1. Size (diameter)
.60	.9995	a. Less than 1/2"
.20	.9997	b. 1/2-1 1/2"
0	.9997	c. 1 1/2-3"
.25	.9994	d. 3" or more
		2. Resistance
0	.9995	a. Light to moderate (4 oz. or less)
.35	.9998	b. Heavy (6-16 oz.)
		3. Distance between edges
.75	.9983	a. Less than 1/2"
.25	.9994	b. 1/2-3/4"
.10	.9997	c. 3/4-1"
0	.9999	d. 1-1 1/2" and up
		4. Control/display movement relationship
0	.9999	a. Clockwise for increase
.50	.9995	b. Counterclockwise for increase

KNOBS (cont.)

Time added	Reliability	
		5. Control/display distance ratio
		a. For scopes (Inches of indicator movement per rotation)
0	.9999	(1) 1" or less
.60	.9998	(2) 2-6"
1.00	.9996	(3) 6" or more
		b. For meters (Proportion of scale traversed by pointer per knob rotation)
.85	.9999	(1) Less than 1/4
.50	.9998	(2) 1/4-1/2
0	.9996	(3) More than 1/2
		6. Knob grip
0	.9999	a. Serrated or knurled
.01	.9997	b. Smooth
		7. Lock mechanism
.25	.9999	a. Present
0	.9996	b. Absent
		8. Clarity of control indications (Labeling, meter scales, indicator lights, etc.)
.10	.9999	a. At least two indications of control positioning
0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

LEVER

(Bar control which moves in a single plane; includes use of wrench or pliers to make adjustment.)

BASE TIME = 1.15

Time added	Reliability	
		1. Length
0	.9990	a. Long lever with arm movement, or short lever with wrist or finger movement
0	.9920	b. Short lever with arm movement
		2. Support of operating member
0	.9990	a. Present
.50	.9950	b. Absent
		3. Plane of movement
0	.9992	a. Vertical
0	.9999	b. Horizontal
		4. Control movement amplitude (Extent of movement from one extreme to the other.)
0	.9964	a. 5-10°
.20	.9970	b. 10-20°
.40	.9975	c. 30-40°
.60	.9985	d. 40-60°

LEVER (cont.)

Time added	Reliability	
		5. Control resistance
		a. Hand operation
0	.9999	(1) 2-5 lbs.
.50	.9992	(2) 10-20 lbs.
		b. Arm operation
0	.9990	(1) 2-5 lbs.
0	.9999	(2) 10-20 lbs.
.50	.9995	(3) 20-30 lbs.
		6. Control/display movement relationship (direction of movement)
0	.9999	a. Direct
1.00	.9985	b. Reverse
		7. Control/display movement ratio (Usually defined in terms of distance.)
1.50	.9957	a. 1:1
1.50	.9970	b. 1:3
1.00	.9983	c. 1:6
.50	.9975	d. 1:15
0	.9985	e. 1:30

LEVEL (cont.)

Time added	Reliability	
		8. Time delay (Time lag between movement of control and movement of display.)
0	.9982	a. .3~.6 sec.
.80	.9985	b. 1.5 sec.
3.20	.9978	c. 3.0 sec.
		9. Clarity of ontrol indications (Labeling, meter scale, indicator iights, etc.)
.10	.9999	a. At least two indications of control positioning
~0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

OBJECT POSITIONING

2. Does not include making cable connections.
3. Time here does not include location shift. If operator takes more than one step in positioning an object, location shift data should be utilized, with due consideration of the parameters listed which are relevant.

BASE TIME = 1.10

Time added	Reliability	
		1. Weight of object
0	.9998	a. 25 lbs. or less
.25	.9997	b. 30-70 lbs.
1.75	.9993	c. 75-100 lbs.
2.75	.9991	d. More than 100 lbs.
3.10	.9994	e. With vehicle support
		2. Area swept (Reflect size and shape; area which would be encompassed by rotation of the object around its primary axis)
0	.9998	a. Three cubic ft. or less
.25	.9997	b. 4-8 cubic feet
1.50	.9992	c. 10-15 cubic feet
2.75	.9985	d. More than 15 cubic feet
		3. Fragileness of object
.80	.9999	a. Requires very careful handling
.15	.9997	b. Requires normal handling
0	.9992	c. Can tolerate rough handling

OBJECT POSITIONING (cont.)

Time added	Reliability	
		4. Locking method
0	.9987	a. None
0	.9990	b. Automatic
.20	.9992	c. Less than 1/4 turn
.40	.9995	d. 1/4 to less than 1 turn
3.20	.9997	e. Clamp
2.75	.9999	f. Pin
6.50	.9999	g. Threaded
		5. Force required for positioning
0	.9998	a. 2 lbs. or less
.25	.9999	b. 2-5 lbs.
.80	.9998	c. 5-10 lbs.
1.10	.9997	d. More than 10 lbs.
		6. Use of tool(s) (Time and error to be considered for each tool used; above scores assume no tools.)
.85	.9990	a. Standard tool (wrench, screwdriver, etc.)
0	.9993	b. Special tool

PUSHBUTTONS

BASE TIME = .57

Time added	Reliability	
		1. Size
.12	.9995	a. Miniature
.07	.9999	b. 1/2"
0	.9999	c. More than 1/2"
		2. Number of pushbuttons in a group
		a. Single column or row
0	.9997	(1) 1-5
.67	.9995	(2) 6-10
1.87	.9990	(3) 11-25
		b. Double column, double row, or row and column
0	.9997	(1) 1-5
.87	.9995	(2) 6-10
1.40	.9992	(3) 11-25
		c. Matrix
0	.9995	(1) 6-10
.20	.9995	(2) 11-25
.95	.9985	(3) 25 or more
		3. Number of pushbuttons to be pushed within a group
0	.9995	a. 2
.30	.9991	b. 4
2.15	.9965	c. 8

PUSHBUTTONS (cont.)

Time added	Reliability	
		4. Distance between edges
.60	.9985	a. 1/8-1/4"
.20	.9993	b. 3/8-1/2"
0	.9998	c. 1/2-up
		5. Detent
.75	.9998	a. Present
0	.9993	b. Absent (switch returns)
		6. Clarity of control indications (Labeling, meter scales, indicator lights, etc.)
.10	.9999	a. At least two indications of control positioning
0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

ROTARY SELECTORS

(Control is usually graduated, may involve discrete or continuous movements.)

BASE TIME = 1.00

Time added	Reliability	
		1. Size
0	.9997	a. 1-2 inches diameter
.11	.9997	b. 2-3" diameter
.31	.9995	c. 3" or more diameter
		2. Resistance
		a. Detent present
.05	.9993	(1) Light to moderate (8-16 oz.)
.35	.9999	(2) Heavy (16-48 oz.)
		b. Detent absent
0	.9995	(1) Light to moderate (4 oz. or less)
.27	.9992	(2) Heavy (6-18 oz.)
		3. Number of positions
0	.9997	a. 3-6 positions
.50	.9992	b. 6-12 positions
1.75	.9975	c. 12 or more positions
		4. Distance between positions
.60	.9975	a. Less than 15^{o}
0	.9998	b. 15-30^{o}
.25	.9996	c. More than 30^{o}

ROTARY SELECTORS (cont.)

Time added	Reliability	
		5. Indicator style (Nature of markings on the control to indicate control position.)
.35	.9995	a. Dot
.27	.9996	b. Line
0	.9999	c. Pointer
		6. Distance between edges of adjacent switches
.70	.9988	a. 1/2"
.20	.9995	b. 3/4-1"
0	.9999	c. 1" and up
		7. Knob grip
0	.9999	a. Serrated or knurled
.01	.9997	b. Smooth
		8. Clarity of control indications (Labeling, meter scales, indicator lights, etc.)
.10	.9999	a. At least two indications of control positioning
0	.9996	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

SPEAKING

BASE TIME = .10

Time added	Reliability	
		1. Number of words or numbers (including repetitions)
0	.9999	a. One
.10	.9999	b. 2-5
.45	.9998	c. 5-10
1.00 or more	.9996	d. More than 10
		2. Number of repetitions
0 (see above)	.9998	a. None
0 (see above)	.9999	b. One
0 (see above)	.9999	c. Two or more
		3. Nature of message
0	.9999	a. Familiar message using common language
.10	.9998	b. Familiar message using uncommon language
.25	.9997	c. Unfamiliar message using common language
.40	.9995	d. Unfamiliar message using uncommon language

TOGGLE SWITCH

BASE TIME = .47

Time added	Reliability	
		1. Size
0	.9997	a. Miniature
.01	.9999	b. Regular
.09	.9999	c. Large
		2. Resistance
.12	.9995	a. Hard (More than 1000 gms.)
0	.9999	b. Soft (Less than 1000 gms.)
		3. Number of positions
0	.9998	a. Two positions
.24	.9991	b. Three positions
		4. Throw direction
0	.9999	a. Vertical
.06	.9996	b. Horizontal
		5. Angle of throw from position to position
0	.9997	a. 20^{o}
.03	.9998	b. 40^{o}
.10	.9999	c. 90^{o}

Time added	Reliability	
		6. Number of switches in a group
		a. Single column or row
0	.9998	(1) 1-5
.55	.9996	(2) 6-10
1.30	.9990	(3) 11-25
		b. Double column, double row
0	.9998	(1) 1-5
.40	.9996	(2) 6-10
1.02	.9992	(3) 11-25
		c. Matrix
0	.9996	(1) 6-10
.15	.9996	(2) 11-25
.70	.9988	(3) 25 and up
		7. Distance between switch centers
.03	.9993	a. 1/2" or less
.02	.9998	b. 3/4"
0	.9999	c. 1" or more
		8. Clarity of control indications (Labeling, meter scales, indicator lights, etc.)
.20	.9999	a. At least two indications of control positioning
0	.9998	b. A single, but clear and concise indication of control positioning
.50	.9991	c. A potentially ambiguous indication of control positioning

WRITING

BASE TIME = 1.00

Time added	Reliability	
		1. Number of words
0	.9999	a. One
1.50	.9999	b. 2-5
12.00	.9997	c. 5-10
25.00	.9996	d. More than 10
		2. Number of digits
0	.9999	a. One
1.00	.9998	b. 2-5
2.00	.9997	c. 5-10
3.50	.9996	d. More than 10
		3. Familiarity
0	.9999	a. Familiar message
1.00	.9997	b. Unfamiliar message
		4. Form
0	.9999	a. Condensed (Writing in one place on one form)
2.00	.9998	b. Dispersed (Writing spread over one or several forms)

LOCATION SHIFT

BASE TIME = 2.00

Time added	1. Number of steps
0	a. 2 steps
.65	b. 3 steps
1.70	c. 5 steps
4.44	d. 10 steps
7.04	e. 15 steps

PERCEPTUAL SHIFT

BASE TIME = .20

Time added	
	1. Complexity of design factors and situational factors
0	a. Optimal design and situation
.60	b. Average design and average situation
2.80	c. Poor design and undesirable situation